COMPOSITE PANEL SYSTEM

Description

The present invention relates to a composite panel system as generically defined by the preamble to claim 1.

In such composite panel systems, such as composite safety glass, once the panel has begun to break there is a so-called "residual load-bearing capacity", which is absolutely necessary for the use of such panels, such as in glazings in the overhead region or in glazings that can be walked on and that secure against collapse. The magnitude of the residual load-bearing capacity can be changed by numerous factors and is thus difficult to estimate. These factors include the type of panel materials used, in the case of composite panel systems the geometry of the layer structure, the type of intermediate layer, and so forth, as well as the manner of load introduction, the ambient temperature, and the breakage pattern of the damage. In the event of an unfavorable choice of these factors, there is often the risk that the residual load-bearing capacity of the composite panel system will be inadequate or no longer adequate.

In the current state of the art, for overhead glazings and glass panel systems that can be walked on and that secure against collapse, not only the load-bearing capacity but the residual load-bearing capacity must be proven, which must always be adapted to the particular component and the safety requirements for it. Proving the residual load-bearing capacity can be done at present only experimentally, however, that is, in tests of original components by order of the building inspectors; in general, one or more panels of the structure to be tested are destroyed in the process, and the

time until complete failure of the panel has to be measured. Complete failure also means that the panel comes entirely or partly loose from its support structure and falls off.

In composite panel systems, it is known to achieve the residual load-bearing capacity solely by means of a homogeneous intermediate layer, for instance of polyvinyl butyral (PVB); depending on the breakage pattern and the strength of the intermediate layer, this residual load-bearing capacity is correspondingly low. The PVB layers used until now do not assure adequate residual load-bearing capacity in certain composite panel systems, since PVB is a thermoplastic that is extremely capable of creepage and thus its material properties are highly temperature-dependent. PVB at room temperature is accordingly relatively readily expandable and is therefore resistant to absorbing tensile forces. Cast resin composites, which from the standpoint of noise abatement are more favorable than PVB, are also known but have practically no or hardly any residual load-bearing capacity, so that composite panel systems of that type offer no safety or security.

The component tests that are often required when permits for construction of a composite panel system are granted by building inspectors are an insupportable financial burden on the building sponsor.

From German Utility Model DE 298 09 607 U1, a composite panel system has also been disclosed in which so-called foreign materials are embedded in the synthetic resin intermediate layer. This design of the composite panel system is intended solely for decorative purposes, for

increasing the decorative design options of such composite panel systems.

From German Patent Disclosure DE 195 39 214 A1, a composite panel system of the type defined at the outset has also been disclosed, in which embedding plastic threads in the plastic intermediate layer is meant to achieve greater fire safety.

The object of the present invention is therefore, even under unfavorable conditions, to assure in advance an increased residual load-bearing capacity in composite panel systems of the types defined at the outset and to prevent the complete breakage and thus separation from the support structure, so that new uses can be opened up to such composite panel systems.

For attaining this object, in a composite panel system of the types defined at the outset, the characteristics recited in claim 1 are provided.

By the provisions according to the invention, the residual load-bearing capacity is increased multiple times over the former values. The residual load-bearing capacity can now be detected computationally, so that expensive component tests are virtually no longer necessary. Mechanically fastening the composite panel system in the support structure and/or mechanically coupling the reinforcing element to the support structure prevents the panel from separating completely from the support structure and causing consequent damage. Further areas of use for such panels are thus possible, such as for the overhead region,

for glass that can be walked on, or as a glazing that secures against collapse, as well as uses as primary load-bearing components. As materials that can be considered, glass is especially important, but other minerally bound materials can also be considered, such as natural stone, ceramic, porcelain, and the like, either alone or in combination.

Advantageous features of the mechanical fastening of the composite panel system in a support structure are obtained by characteristics of one or more of claims 2 through 4. The size of the fastened portion relative to the length of the composite panel system is essential and is also intended to assure anchoring of the composite panel system in the support structure on the applicable edge even if the composite panel sags as a result of breakage, thus reducing the size of the fastened portion. The fastening can be provided continuously over the entire width, or intermittently, transversely to the length of the composite panel. A sufficiently high transverse pressure of the clamping construction exists if the fastening of the composite panel is assured even after the composite panel breaks.

The mechanical coupling of the reinforcing element to the support structure can be provided inside the panel, in accordance with the characteristics of claim 5, or peripherally outside the panel, in accordance with the characteristics of claim 6. Which of these two types will advantageously be used depends in particular on the type of support structure, that is, whether it involves individual bolts or a framelike support structure.

With the characteristics of claim 7, a more-uniform load-bearing capacity is obtained over the entire panel surface, regardless of its installed and braced position.

For the reinforcing element, various materials in different forms can be used, as disclosed by the characteristics of one or more of claims 8 or 9 and 10 through 16. Depending on the type and design of the reinforcing element, various possibilities of mechanical coupling to the support structure are obtained. For instance, looplike connections as well as soldered connections and the like to the support structure are possible. Depending on the type of material and the form of inlay, additional advantages are obtained, such as a reduction in light transmission for the sake of also attaining protection against sunlight in the case of various glasses. Also in glasses, the reinforcing element can serve the purpose of vision protection, on the order of a curtain. It is also possible now for the noise abatement properties known from cast resin composites to be exploited for the safety field as well.

Advantageous provisions in the construction of such composite panel systems will become apparent from the characteristics of claims 17 and 18.

Especially advantageous applications will become apparent from the characteristics of claims 19 and/or 20.

Further details of the invention can be learned from the ensuing description, in which the invention is described and explained in further detail in terms of exemplary

embodiments shown in the drawing. Shown are:

Fig. 1, in a schematic, perspective and partly cutaway view, the structure of a composite panel in a first exemplary embodiment of the present invention;

Figs. 2A and 2B, views corresponding to Fig. 1, but for a second and third exemplary embodiment, respectively, of the present invention;

Fig. 3, a view corresponding to Fig. 1, but for a fourth exemplary embodiment of the present invention;

Fig. 4, in a schematic, perspective, exploded view, the structure of a composite panel in a fifth exemplary embodiment of the present invention; and

Figs. 5A and 5B, exemplary embodiments for joining the composite panel or its reinforcing elements to a support structure.

The composite panel system 10, 110, 210, 310 and 410 shown in several exemplary embodiments in the drawing, which because of its increased residual load-bearing capacity is used as a safety-type composite panel system and can be employed in the overhead region and/or as a system that can be walked on or secures against collapse (both vertically and horizontally), has a two-panel structure of practically arbitrary surface area in the exemplary embodiments shown. Although below, in terms of the exemplary embodiment shown, glass panels are discussed, it is understood that the panels used can also comprise some other brittle material, such as

natural stone, ceramic, porcelain and the like. Such a composite panel system can also be constructed with panel elements of the same material or different materials. Furthermore, composite panel systems with more than two panel elements are possible.

In accordance with the drawing an upper glass panel 11 and a lower glass panel 12 of a desired surface area, each with a desired thickness, are provided. The glass panels 11, 12 can be made from float glass, tempered safety glass, TVG glass or other improved glasses. Between the two glass panels 11 and 12, an adhesive intermediate layer 14 is provided, which is made for instance from a polyvinyl butyral (PVB) layer.

In the exemplary embodiments of Figs. 1, 2A, 2B and 3, the intermediate layer 14 is a uniform layer in which a reinforcement 15, 115, 215 and 315, respectively, is placed. In the exemplary embodiment of Fig. 4, the intermediate layer 14 is assembled from one layer element 14' adjacent to the upper glass panel 11 and one layer element 14'' adjacent to the lower glass panel 12. A reinforcement 415 is placed between the two layer elements 14' and 14'' of the intermediate layer 14.

The reinforcement serves to enhance or increase the load-bearing safety of the composite panel system 10, 110, 210, 310 and 410, and in the finished state of the composite panel system shown in Figs. 1, 2A, 2B and 3 it is embedded in the adhesive intermediate layer 14. Glass fibers, carbon fibers and metals can be considered as materials for the reinforcement 15, 115, 215, 315 and 415. The form of inlay

of the reinforcement 15, 115, 215, 315 and 415 varies in the various exemplary embodiments shown. In Fig. 4, for instance, the reinforcement 415 is a grid of one of the aforementioned materials, and the grid can be coated in some suitable way. It is understood that as a form of inlay, woven fabric, ribbons, rovings, yarns, cords, twisted yarns, threads, metal profiles, or prestamped thin metal sheets, such as perforated metal sheets, are also suitable.

In the exemplary embodiment of Fig. 1, the reinforcement 15 is formed by cords, which extend in a meander pattern in one direction of the composite panel system 10, while the loops 21 created by the meander 18 extend out past the two opposed edges 22 of the panel 10.

In the exemplary embodiment of Fig. 2A, the reinforcement 115 is formed by two meanders 18 and 19 disposed perpendicular to one another, whose loops 21 and 23 created by the respective meander pattern extend out past the applicable edges 22 and 24 of the composite panel 110.

It is understood that in both of these exemplary embodiments, the reinforcing cords 15, 115 for forming the loops 21, 23 can also each be inlaid in the form of a single elongated oval.

The outward-extending loops 21, and 21 and 23, respectively, of the reinforcements 15 and 115 are coupled mechanically or joined in a manner not shown to a support structure, also not shown here, of the composite panel 10 and 110, respectively. For instance, if the support structure secured to the building is formed by parallel rails or by a

frame, then the respective loops 21, and 21 and 23, that extend outside can be clamped, soldered together, or similarly fixed between the rails or the frame. For instance, if the support structure is formed by individual bolts, then the loops 21, 23 can be suspended from the supporting bolts and fixed in some way suitable for the material involved.

In the exemplary embodiment of Fig. 2B, the reinforcement 215 is formed by a grid of elongated ribbons, fibers, braided cables, wires or the like extending parallel and perpendicular to one another, whose free ends 221, 223 are extended out of the applicable edges 222 and 224 of the composite panel 210. In the exemplary embodiment shown, these elongated reinforcing elements are shown in the form of braided cables or the like, whose ends 221 and 223 extended out of the composite panel 210 are twisted open. Also in Fig. 2B, a support structure in the form of a frame 31, shown only in part, can be seen onto which the twisted-open ends 221, 223 are for instance firmly soldered.

In the exemplary embodiment shown in Fig. 3, the reinforcement 315 is likewise formed for example of wires, braided cables, cords, ribbons or the like, which extend in one direction or, as shown here, crosswise and parallel to one another at a certain spacing. In certain regions, such as regions of the composite panel 310 near the corners, two parallel-extending strands 27 each of the cords are interrupted in their parallelism via helical windings 28 resting on one another and are then extended onward. These helical windings 28 surround a bore 29 that penetrates the composite panel 310. In a manner not shown, the bores 29

serve to receive a support structure, also not shown, that for instance protrudes from a building wall; the helical windings 28 of the strands 27 of the cords of the reinforcement 315 are joined to the applicable support structure, such as stay bolts. It is understood that these mechanical coupling regions 28, 29, which in this exemplary embodiment are within the outline of the composite panel 310, can be provided at arbitrarily selected regions of the composite panel 310. The other strands 27' of the cords of the reinforcement 315 are cut off at their ends peripherally of the composite panel 310.

The mechanical coupling of the reinforcement 15, 115, 215 and 315 to the support structure or substructure (for instance 31), shown only in part, of the composite panel 10, 110, 210 and 310 prevents the panel, in the event of breakage, from separating from its support structure and causing consequent damage.

It is understood that, although not shown, a corresponding mechanical coupling of the reinforcement 415 is provided for the composite panel 410 of Fig. 4 as well.

It is understood that the mechanical coupling of the reinforcement and the support structure of the panel will vary depending on the type of reinforcement; for instance, a wraparound tie, clamping connection, soldered connection or the like can be provided. Depending on the type of support structure, mechanical coupling will be done either inside or outside the panel.

Figs. 5A and 5B show exemplary embodiments for

connecting a composite panel system 10, 110, 210, 310, 410 to a support structure 131 and 231, respectively, shown here as an example.

Fig. 5A shows a support structure 131 in the form of two parallel, rigid plates 32 and 33, which are provided for instance continuously over the length of one edge of a composite panel system 410. The applicable edge 422 of the composite panel system, at which the reinforcing elements 415 are not extended outward, is thrust between the plates 32 and 33 by a certain amount of the length of the composite panel 410, and the plates have a clamping construction 34, so that a relatively high transverse pressure for clamping purposes can be brought to bear on the inserted composite panel or its peripheral region. To that end, the plates 32 and 33 oriented toward the composite panel are provided with clamping jaws 35, while on the side remote from them of the clamping screw unit 34 they are provided with a spacer 36. Thus the composite panel system 410 is fastened on one side in the carrier 33 of the support structure 131. The size of the fastening zone between the plates 32 and 33 is such that in the event of breakage of the composite panel system 410, adequate clamping is still assured.

Fig. 5B shows a support structure 231 in which two adjacent composite panel systems 110 and 110' are fastened in place and held together; in addition to the clamping of the edges of the composite panels, a mechanical coupling of the reinforcing elements to the support structure 231 is simultaneously achieved.

In the exemplary embodiment shown, the support

structure 231 has a bridgelike carrier 37 and a spaced-apart flat carrier 39, which can be moved toward one another by means of a screw connection 38. Between the two carriers 36 and 37, the applicable edges of adjacent composite panels 110, 110' can be fastened or clamped in place. The carriers 37 and 39 have toothlike clamping jaws 41, with which a suitably strong clamping force can be exerted by tightening the screw connection 38. The bolt 42 of the screw connection 38 simultaneously acts as a coupling element for mechanically coupling the loops 121, 121' of the reinforcing element 115 that are extended out of the edges of the composite panel systems 110, 110'. The loops 121, 121' are retained for instance between clamping disks or jaws 43, 44 that are connected with the screw connection 38.

It is understood that the connection shown in Fig. 5B for the composite panel system 110 with a support structure 231 can also be combined with a support structure 131 of Fig. 5A on the opposite side. In this kind of two-sided fastening of the composite panel system, it is achieved that even if the composite panel breaks and consequently sags, the clamping on both sides together with the mechanical coupling of the reinforcing elements to the one support structure assures a hold of the composite panel system.

In Fig. 4, the composite panel system 410 is produced in such a way that after the parts 11, 12 and 14', 15''', 14'' are placed on one another, the reinforcement 415 is embodied in the intermediate layer 14 by the application of heat and pressure, and the adhesive bonding of the two glass panels 11 and 12 is effected via the intermediate layer 14.

In an exemplary embodiment not shown, the reinforcement 15 is put between the upper glass panel 11 and the lower glass panel 12, and the two panel elements are kept spaced apart and are sealed at the edges. Through an opening, the interior defined by the two panel elements 11 and 12 is potted with a casting resin, a suitable plastic, or the like, and the reinforcement is embedded in the casting resin or plastic potted composition.

As noted, a composite panel system comprising other materials than glass, with otherwise the same or different material, can be produced in a corresponding way. It is also possible in a corresponding way to produce a composite panel system made of more than two panels.

The adhesive intermediate layer 14 is embodied or selected to suit the type of material comprising the panel. If glass panels are selected as the panels, it is expedient for the intermediate layer to be embodied as transparent. The same is true for the materials used for the reinforcement, which when glass panels are used in the composite panel system simultaneously has the capability of lessening the light transmission, providing a vision protection function, or even certain design functions. If casting resin is used as the intermediate layer, a previously unattained combination of noise abatement and adequate residual load-bearing capacity is achieved.